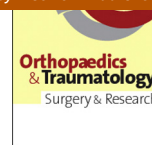




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## Case report

# The Targon PH<sup>®</sup> nail for distal femoral fracture fixation in disabled children. A report of three cases



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## ABSTRACT

Recommendations for distal femoral fracture treatment in children with neuromuscular disease are various, including conservative, plating, nailing, and ESIN. All methods have disadvantages. Retrograde femoral intramedullary nailing using a statically interlocked Targon PH nail was performed in three cases. A right nail was used for a right femur (and vice versa). A short nail was used for supracondylar fractures, a long nail for distal femoral shaft fractures. Closed reduction was performed in all cases. Despite osteopenia, small bone dimensions and muscle dystrophy, no intraoperative or postoperative complications occurred. All cases achieved primary stability, allowing immediate rehabilitation. Bone healing occurred uneventfully within four months. No deterioration of functional status or range of motion was seen. There were no peri-implant fractures or hardware removal need over a two-year-period. Retrograde femoral nailing with the Targon PH nail seems to be a reasonable treatment concept for these rare and demanding cases.

Level of evidence: IV.

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## 1. Introduction

Femoral fractures are common in neurologically disabled children, however optimal treatment remains unclear [1–7]. A MEDLINE search using the phrases “distal femoral fracture”, “supracondylar fracture”, “children”, “pediatric”, “adolescent”, “disability”, “handicap”, “myopathy”, “Duchenne”, “cerebral palsy”, and “neuromuscular disease” was conducted.

Non-disabled pediatric populations have a femoral shaft fracture incidence of 2.5 cases per 10,000 annually [8]. All recommended fixation techniques have drawbacks: reoperations or mal-unions occur frequently after external fixation (30%) or ESIN (10%) [9,10]. Submuscular bridge plating includes a danger of refractures [9,11,12], valgus deformity [13], stress shielding, and screw tip prominence [14]. Complication rate seems low after rigid (antegrade) nailing [9].

In handicapped children, femoral fractures are common [7,15]. Joint contractures, bone deformity, and osteoporosis provoke the fractures [7,16–18]. Cast immobilization reduces physical activity for 18 months [19] and bone mineral mass for 6 months [20]. These

findings disfavour conservative treatment concepts as advocated by some authors [1,15,21].

A series of ESIN stabilization of 6 distal femoral fractures in children with myopathy reported good outcomes, but difficulties in the operative technique (bad nail entry, nail penetration, fracture distraction) [22].

Publications advocating plate fixation [23–25] are based on small non-pediatric or non-disabled collectives (Table 1). Reports on rigid nail fixation are missing.

## 2. Operative technique

Treatment objectives (Table 2) were determined by an interdisciplinary team of trauma surgeons, paediatricians and nursing experts [22].

Since femoral interlocking nails are not available in adequate design and size we developed a fixation concept using a standard proximal humeral nail (Targon PH, Aesculap, Tuttlingen, Germany).

Preoperative planning was performed using mediCAD<sup>®</sup> (HECTEC, Landshut, Germany). Retrograde femoral nailing was performed with an unreamed right Targon PH nail for a right femur (and vice versa). The operation was performed under general anesthesia in supine position without traction table. In knee flexion (60°) the nail was inserted through a limited infrapatellar

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**Table 1**  
Overview on current literature on distal femoral fracture treatment in specific situations.

Authors	Fixation method	Number of fractures reported	Reason of disability	Major findings
Huber et al. (2012) [22]	ESIN	6	Duchenne muscular dystrophy, nemaline myopathy	All fractures healed, no mal-alignment reported Early mobilization into wheelchair possible Open reduction in case of displaced fracture Crossing of distal epiphyseal plate mandatory No worsening of contractures
Wang et al. (2013) [23]	Locking plate	19	Poliomyelitis	All fractures healed, one delayed union (5%) Minimal callus formation reported Good functional outcome on 2-year-follow-up Adult patients
El-Sayed Khalil (2010) [24]	Locking plate	13	Poliomyelitis	All fractures healed, one after additional bone grafting (8%) Problems due to small bone dimensions reported Good functional outcome on 18-month-follow-up Adult patients
Abdelgawad (2010) [25]	Proximal humeral plate	2	No disabilities reported	Healing in good alignment, full ROM of the knee Knee immobilizer was used for 2 weeks Multiple screw options allow to stay proximal of the physis

**Table 2**  
Major and minor objectives of treatment in children being severely disabled by neuromuscular or brain disease.

Major objectives	Minor objectives
Relief of pain Urgent resumption of physiotherapy in order to avoid progress of the underlying disease Ease nursery Avoidance of further damage to the muscles	Good reduction/alignment Safe wound healing

incision, splitting the patellar tendon. Static interlocking was performed.

3. Results

We treated 3 fractures in two patients (Table 3). Osteopenia and narrow intramedullary cavities were evident in every case. For the two distal shaft fractures a long version of the nail was used (Fig. 1), whereas the supracondylar fracture was fixed with a short nail (Fig. 2). Operative time was 89–103 minutes. No intraoperative or postoperative complications occurred. A Kirschner wire according to Stedtfeld's blocking screw principles [26] was used in

two cases in order to facilitate closed reduction, which was performed in all cases. All fixations were primarily stable for exercise; no plaster cast was required. Physiotherapy was continued on the first post-operative day under mild analgesia. Wound healing occurred uneventfully. Average hospital stay was 5 days. On 4-month follow-up, bone healing and callus formation was evident (Fig. 3). Functional status was equivalent to pre-trauma. A 20° knee extension deficit remained unchanged in 2 cases, whereas a contracture of 15° completely resolved in the short nail case with the distal fragment fixed in slight extension. Flexion was unchanged in all cases (110°). We found no implant loosening, loss of alignment, refractures, or no need of implant removal for two years.



**Fig. 1.** Pre- and postoperative x-rays of a 15-year-old boy with Duchenne muscular dystrophy, fixed with a long Targon PH nail for distal femoral shaft fracture.



**Fig. 2.** Pre- and postoperative x-rays of a 12-year-old girl with Dandy-Walker syndrome, fixed with a short Targon PH nail for displaced supracondylar fracture.

**Table 3**

Overview on patient demographics and follow-up of our series.

Gender, age at surgery	Pathology	Fracture type	Injury mechanism	Fixation concept	Follow-up
Boy, 15 years	Duchenne dystrophy	Distal diaphyseal	Fall from wheelchair	Unreamed Targon PH long retrogradely inserted	4 months radiographically 3 years telephone interview
Boy, 15 years	Duchenne dystrophy	Distal diaphyseal	Fall from wheelchair	Unreamed Targon PH long retrogradely inserted	4 months radiographically 3 years telephone interview
Girl, 12 years	Dandy-Walker syndrome	Supracondylar	Normal nursery activities	Unreamed Targon PH retrogradely inserted	4 months radiographically 2 years telephone interview

#### 4. Discussion

One author recommends conservative treatment, but emphasizes the danger of reduced mobility after immobilization [4,15]. In our series, conservative treatment was ruled out due to the need for continuous physiotherapy. Plate fixation seemed inappropriate because of muscle atrophy (limited soft tissue coverage). ESIN fixation was precluded for missing cortical resistance due to osteopenia.

Intramedullary locking nail fixation was favoured for combining less-invasive, muscle-sparing approach and stable fixation. However, the only available nail designed for adolescents is the ALFN (Expert Adolescent Lateral Femoral Nail, Synthes, Switzerland), which is a titanium nail with diameters down to 8.2 mm. It can be used for antegrade nailing only and has limited distal interlocking options, precluding a stable fixation of distal femoral fractures. Consistently, its official indications include subtrochanteric and shaft fractures only.

##### 4.1. Targon PH nail for retrograde femoral nailing

Proximal humeral nails have smaller diameters than femoral nails. The Targon PH nail (Aesculap, Tuttlingen) is a straight nail with a diameter between 10 mm (metaphyseal part) and 7–8 mm (diaphyseal part). The standard nail has a length of 150 mm, but there are versions of 220 mm, 250 mm, and 280 mm. There are stable interlocking options at its metaphyseal part [27].

We developed an off-label fixation concept for distal femoral shaft fractures and supracondylar fractures in specific situations. As preservation of the epiphyseal plate is not a major objective

in heavily handicapped adolescents, retrograde insertion seemed an excellent option for less-invasive approach. According to our technique, a right Targon PH nail is used for a right femur (and vice versa).

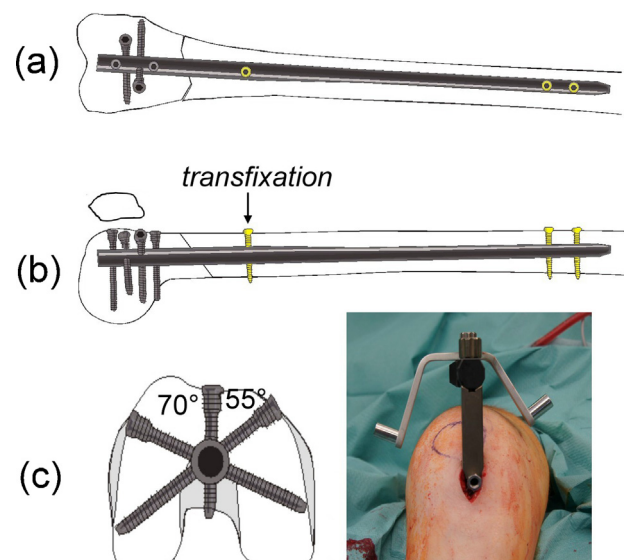
The advantages of retrograde femoral nailing with a Targon PH nail include (see also Fig. 4):

- usage of short or long nail versions, depending on fracture type and location;
- good filling of the medullary cavity, providing more stability;
- stable, three-dimensional interlocking by up to four screws in the epiphyseal zone, below the epiphyseal plate;
- interlocking options immediately proximal to the supracondylar zone. In supracondylar fractures this *transfixation interlocking* provides additional stability [28];
- additional proximal interlocking options in the long nail;
- no conflict between interlocking and patellofemoral joint (Fig. 5).

Because of the small bone dimensions and possible pre-existing deformities, preoperative planning should ensure that the selected nail will pass even through the narrowest point of the medullary cavity (Fig. 6). In our series, the short nail was used for the supracondylar fracture, and long nails were used for distal diaphyseal fractures. Our limited data does not allow drawing conclusions on whether to prefer long or short nails. However, we recommend usage of long nails whenever possible in order to minimize the risk of future peri-implant fractures, which in our hands would result in conversion to a long nail.



**Fig. 3.** Marked callus formation 3 months postoperatively. Note distal fragment fixation in slight extension on the lateral view, reducing flexion contracture.

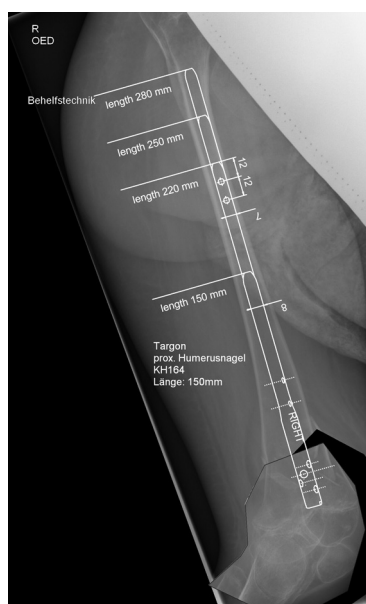


**Fig. 4.** Fixation concept illustrated with a right femur and a right Targon PH nail. There are four interlocking options in the epiphyseal part of the bone (a). Distal interlocking can be combined with transfixation interlocking and proximal interlocking (b). The three-dimensional distal interlocking corresponds well to the axial shape of the distal femur (c).





**Fig. 5.** Two of four distal interlocking options are oriented strictly in anteroposterior direction. During interlocking screw insertion there is no conflict with the patella (here marked by a blue circle on the skin), which is located several centimetres distally. With the leg in extension however the patella may reach the most distal interlocking screw, which therefore must not protrude.



**Fig. 6.** Preoperative planning helps the surgeon to check for implant size and positioning.

We consider static retrograde femoral nailing with the Targon PH nail suitable for distal shaft fractures and supracondylar fractures in all children and adolescents affected by severe myopathic disease. Neither osteoporosis nor reduced soft tissue coverage are limitations for this method. Preoperative planning is recommended.

#### Disclosure of interest

All authors received grants from B. Braun Aesculap (Tuttlingen, Germany) within the past 5 years for consulting activities. HWS is also receiving royalties from the same company.

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